Real Supports

نسألكم الدعاء

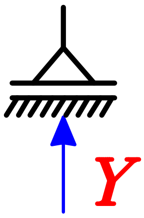
IF you download the Free ***APP.*** RC Structures *on your smart phone or tablet, you will be able to play illustrative movies For any paragraph that has a QR code icon*

اذا حملت تطبيق RC Structures على تليفونك المحمول او اللوح السطحى ستستطيع أن تشغل أفلام شرح للمقاطع التى تحتوى على رمز

Real Supports Table of Contents.

Real Supports

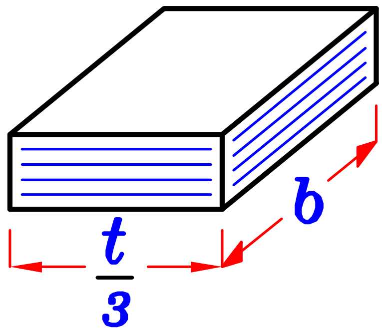
① Real Roller.

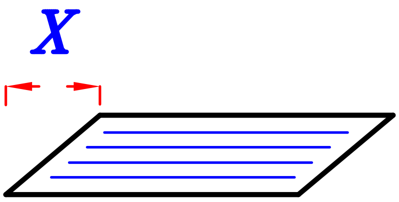


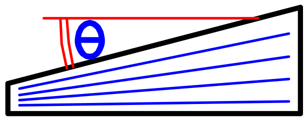
Using: Lead Plat. or Neoprene Plate.

Neoprene Plate.

ال Neoprene Plate هى ألواح من الصلب بينها شرائح من المطاط المضغوط.
توضع بين العمود و الكمره أو بين العمود و القاعده لعمل Real Hinge
و فائدتها أنها تسمح بالحركه الافقيه و الدوران .

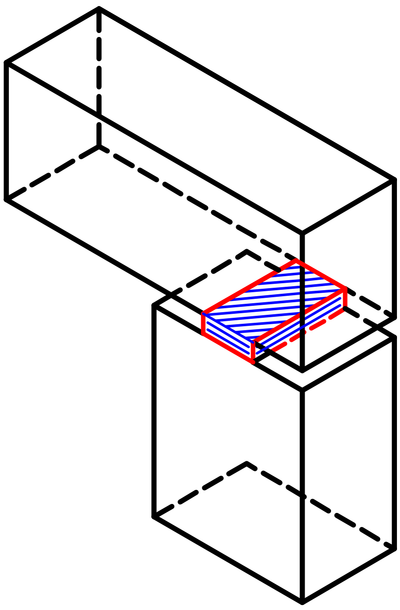




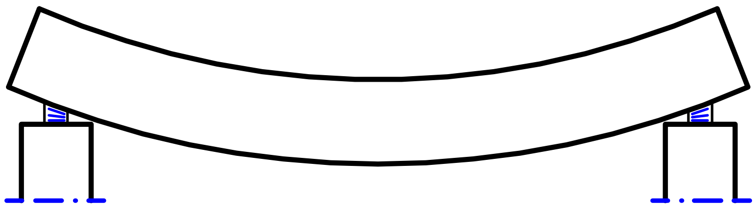


الحركة الافقية X الدوران θ

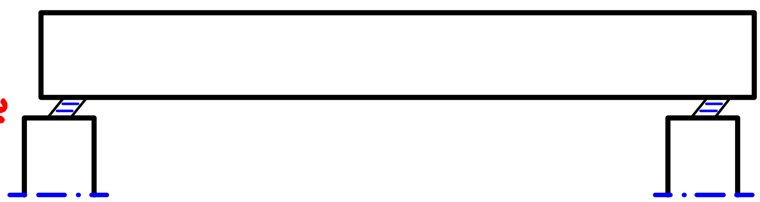
تسمح بالحركه الافقيه و تسمح بالدوران



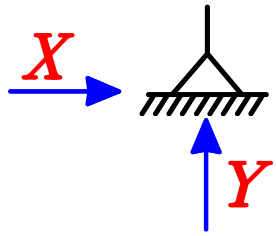
تسمح بالدوران
أي لا تنقل عزوم
على العمود



تسمح
بالحركه الافقيه



② Real Hinge.



Types of Real hinges.

① Lead Plate Hinge.

② Cross bars Hinge.

③ Spiral Hinge.

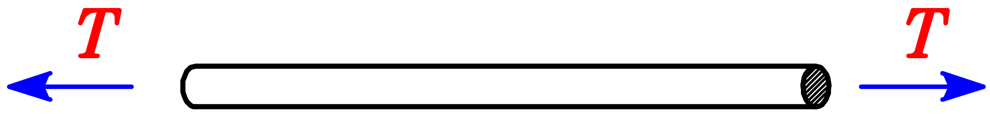
For All Types of Real Supports We have to :

- Check Bearing Stresses.
- Calculate Stirrups.

Allowable stress For Steel Bars.

الاجهادات التى يتحملها سيخ الحديد بدون خرسانة

① **Allowable stress For Steel Bars in Tension** $= \left(\frac{F_y}{\gamma_s}\right)$



$$\boxed{A_s = \frac{Force}{Stress} = \frac{T}{(F_y \backslash \gamma_s)}}$$

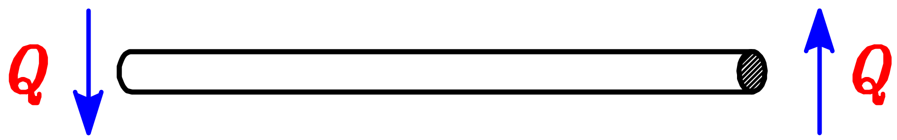
② **Allowable stress For Steel Bars in Compression** $= 0.60 \left(\frac{F_y}{\gamma_s}\right)$

$$\boxed{A_s = \frac{Force}{Stress} = \frac{P}{0.60\ (F_y \backslash \gamma_s)}}$$

ملحوظة

اذا لم نستطع تحديد نوع القوى اذا كانت **Tension or Compression**
نعتبرها **Compression**

③ **Allowable stress For Steel Bars in Shear** $= 0.60 \left(\frac{F_y}{\gamma_s}\right)$

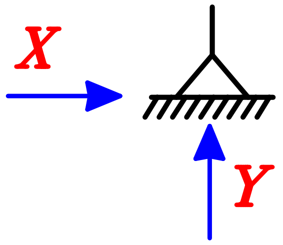


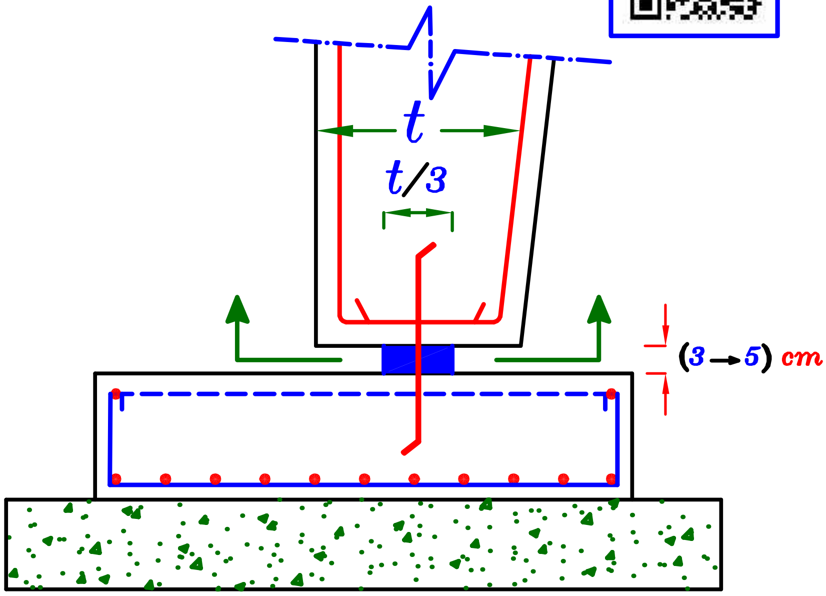
$$\boxed{A_s = \frac{Force}{Stress} = \frac{Q}{0.60\ (F_y \backslash \gamma_s)}}$$

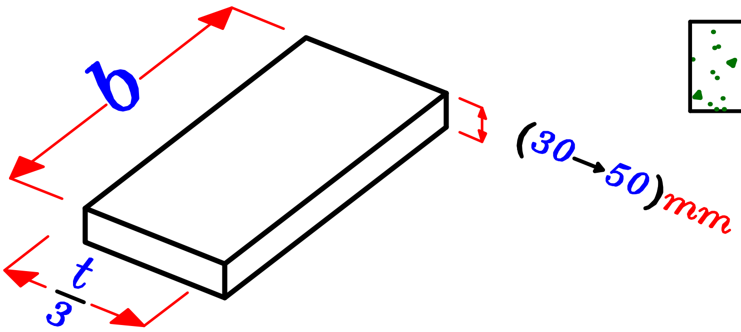
① Lead Plate Hinge.

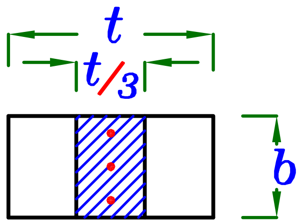
Using: *Lead Plat.*

OR *Neoprene Plat.*









نستخدم لوح الرصاص فى نقل القوى الرأسية $Y_{U.L.}$ من العمود إلى القاعده •

و تكون أبعاد لوح الرصاص $\left(b * \frac{t}{3} * (30 \rightarrow 50)\ mm \right)$

نستخدم أسياخ الحديد الرأسية *Longitudinal Bars* لنقل القوى الأفقية $X_{U.L.}$ من العمود إلى القاعده •

و لحساب مساحة أسياخ الحديد الرأسية *Longitudinal Bars*

$$A_s = \frac{X_{U.L.}}{0.60\ (F_y \backslash \gamma_s)}$$

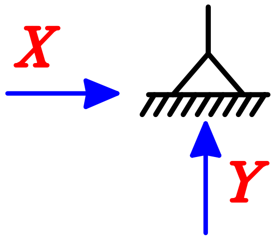
$$\phi > 18\ mm$$

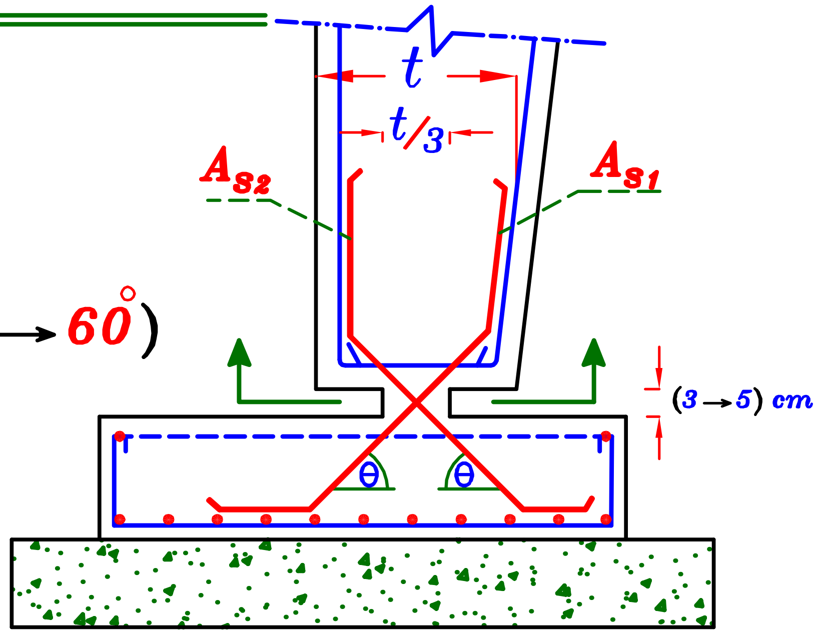
$$\text{min. } 2\phi 20$$

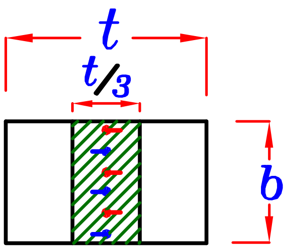
Where: $0.60\ (F_y \backslash \gamma_s)$ = *Allowable Shear stress For Steel in U.L.D.M.*

② Cross Bars Hinge.

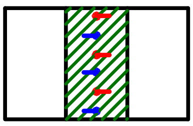
$\theta = (30^\circ \rightarrow 60^\circ)$







نعتمد على نقل القوى الأفقية و الرأسية بواسطة الحديد فقط.

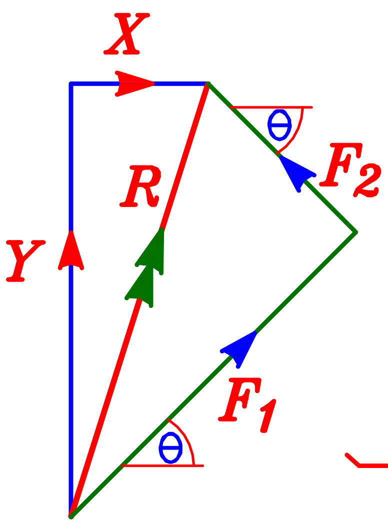


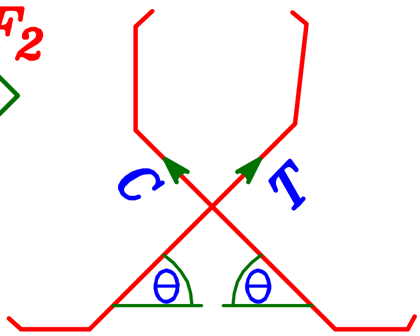
أكبر عدد أسياخ ممكن وضعة فى الـ *X-Hinge* هو ٦ أسياخ فقط

(ثلاثة جهة اليمين و ثلاثة جهة اليسار).

لذا لا نستخدم الـ *X-Hinge* إلا عندما تكون R صغيره.

و لحساب مساحة أسياخ الحديد A_{s2} , A_{s1}





$$A_{s1} = \frac{F_{1\,U.L.}}{0.6\,(F_y \backslash \gamma_s)}$$

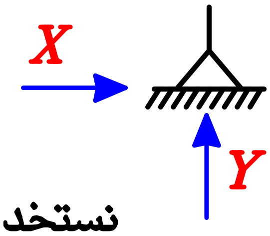
$$A_{s2} = \frac{F_{2\,U.L.}}{0.6\,(F_y \backslash \gamma_s)}$$

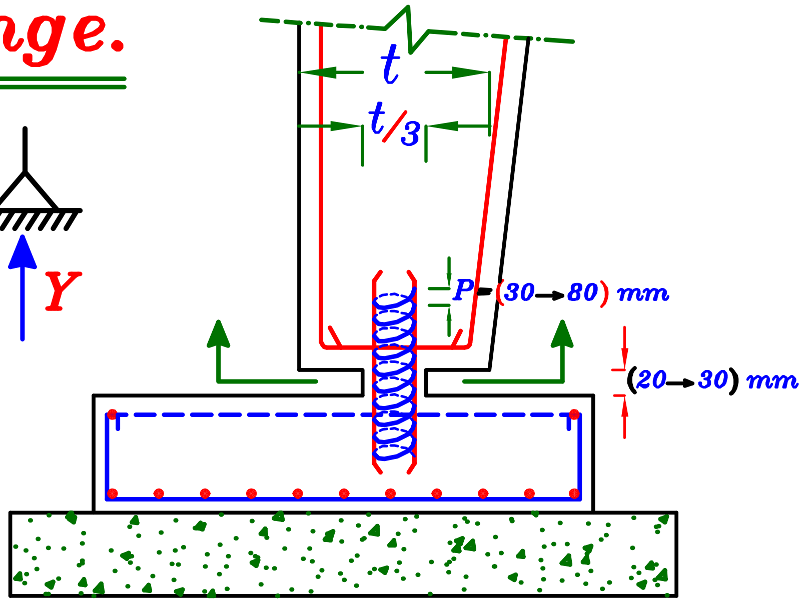
نقلل من قوه تحمل أسياخ الحديد الى $0.6\,(F_y \backslash \gamma_s)$

لأن بعض هذه الاسياخ يتعرض لـ *Compression*.

③ Spiral Hinge.

$Y_{U.L.} \ngtr 1800$ kN



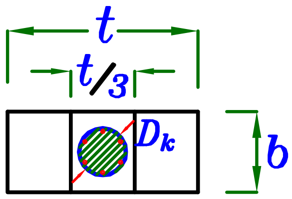


نستخدم ال **Spiral Steel**
لنقل القوى الرأسية فقط
و نستخدم أى **System** أخر
لنقل القوى الأفقية

- D_k = Diameter of the Spiral

$$= b - 50 \text{ mm}$$
$$= \frac{t}{3} - 50 \text{ mm}$$

} الأقل



min. no. of bars = 6 Bars

- $A_k = \dfrac{\pi D_k^2}{4}$ مساحة قلب القطاع الخرسانى المحدد بدائره الكانة الحلزونية

To Get A_s $\quad Y_{U.L.} = P_{U.L.}$ (Spiral)

use $P_{U.L.} = 0.35\, A_k\, F_{cu} + 0.67\, A_s\, F_y + 1.38\, V_{sp}\, F_{yp}$

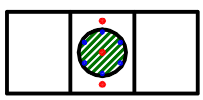
or use
$$\boxed{P_{U.L.}(\text{Spiral}) = 1.14\,(0.35\, A_c\, F_{cu} + 0.67\, A_s\, F_y)}$$

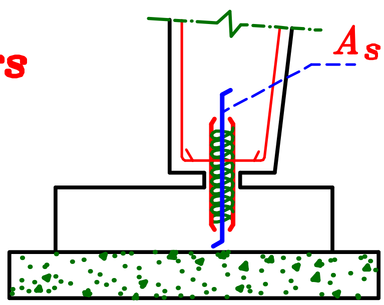
where: $A_c = A_k$, $F_y = 2400$ kg\cm²

To Resist $X_{U.L.}$ Use Longitudinal bars or X–bars

- IF $X_{U.L.}$ is small use Longitudinal bars

$$A_s = \frac{X_{U.L.}}{0.60\,(F_y \backslash \delta_s)}$$

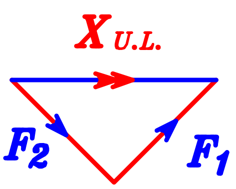


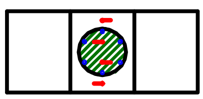


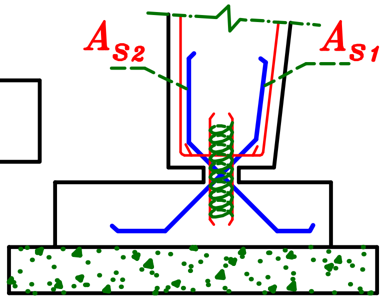
- IF $X_{U.L.}$ is big use X–bars

$$A_{s1} = \frac{F_{1\,U.L.}}{0.6\,(F_y \backslash \delta_s)}$$

$$A_{s2} = \frac{F_{2\,U.L.}}{0.6\,(F_y \backslash \delta_s)}$$

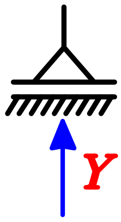




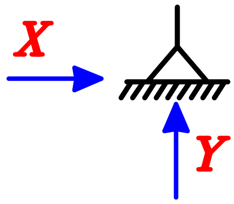


Check Bearing Stresses.

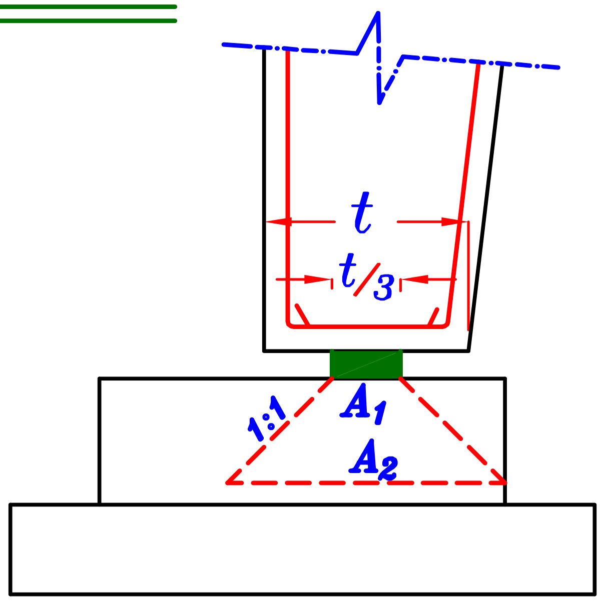
For All Types of Real Supports.



Real Roller



Real Hinge



يجب التأكد من أبعاد ال **Real Support** $\left(b*\frac{t}{3}\right)$ عن طريق **Check Bearing.**

① Calculate Allowable Bearing Stress.

$$\boxed{F_{b\,all.} = \frac{2}{3}\,\frac{F_{cu}}{\gamma_c}\sqrt{\frac{A_2}{A_1}}}$$

Where:

$A_1 =$ مساحة التحميل Take $A_1 = \left(b*\frac{t}{3}\right)$

$A_2 =$ أكبر مساحة تحميل متماثلة مع (A_1) Take $A_2 = (b*t)$

$\sqrt{\frac{A_2}{A_1}} \ngtr 2$ IF we take $A_1 = \left(b*\frac{t}{3}\right)$, $A_2 = (b*t)$ $\longrightarrow \sqrt{\frac{A_2}{A_1}} = \sqrt{3}$

$\therefore$ **Allowable Bearing Stress.**

$$\boxed{F_{b\,all.} = \frac{2}{3}\,\frac{F_{cu}}{\gamma_c}\sqrt{3}}$$

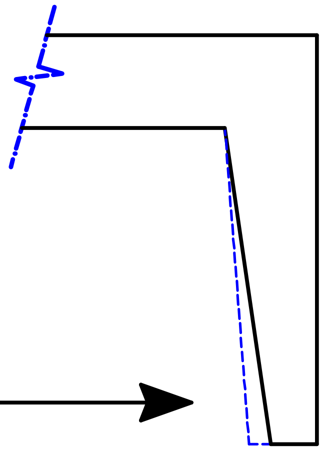
② Calculate Actual Bearing Stress.

$$\boxed{F_{b\,act.} = \frac{Y_{U.L.}}{(b * \frac{t}{3})}}$$

To Check Bearing.

- IF $F_{b\,all} \geqslant F_{b\,act}$ $\therefore$ Safe
- IF $F_{b\,all} < F_{b\,act}$ $\therefore$ UnSafe

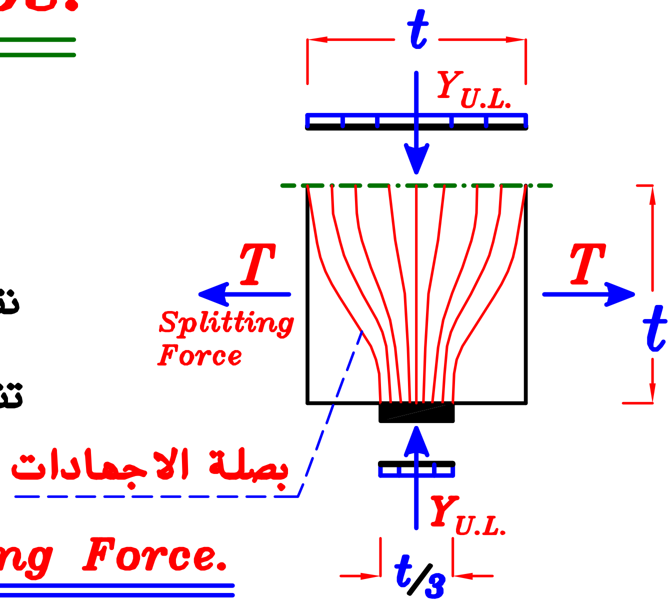
We have to Increase A_1 $\longrightarrow$



Design of stirrups.

نتيجة نقل الحمل من عرض $\frac{t}{3}$ الى عرض t

تنتج قوى شد أفقية *Splitting Force* (T)



Calculation the value of Splitting Force.

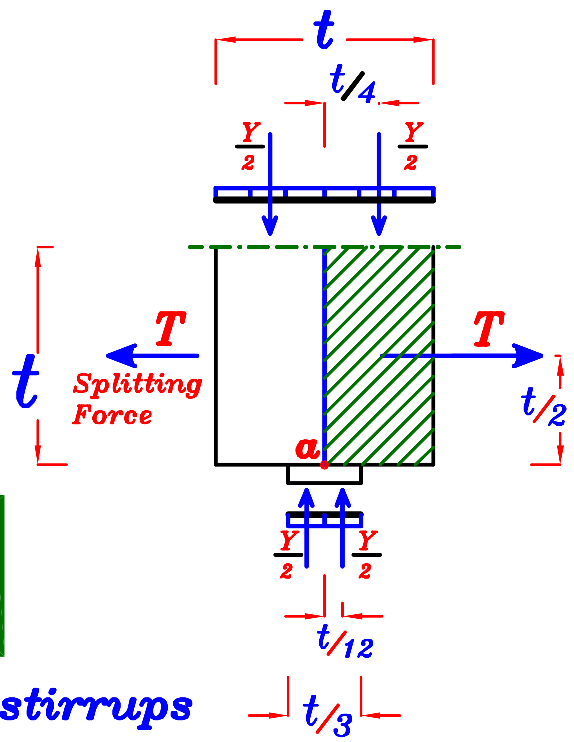
$$M_{a\,(Ext.)} = M_{a\,(Int.)}$$

$$M_{a\,(Ext.)} = \frac{Y}{2}\left(\frac{t}{4} - \frac{t}{12}\right) = \frac{Y\,t}{12}$$

$$M_{a\,(Int.)} = T\left(\frac{t}{2}\right)$$

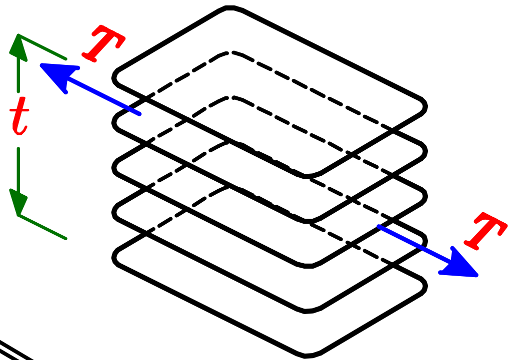
$$\because\; M_{a\,(Ext.)} = M_{a\,(Int.)}$$

$$\therefore\; \frac{Y\,t}{12} = T\left(\frac{t}{2}\right) \longrightarrow \boxed{T = \frac{Y}{6}}$$



To Resist Splitting Force We use stirrups

$$\boxed{T = 2\,n\,A_s\left(\frac{F_y}{\delta_s}\right)}$$



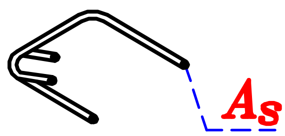
Where:

$n =$ عدد الكانات فى الإرتفاع t

A_s مساحة سطح السيخ الواحد من الكانة

IF using $\phi 8 \longrightarrow A_s = 50.3\ mm^2$

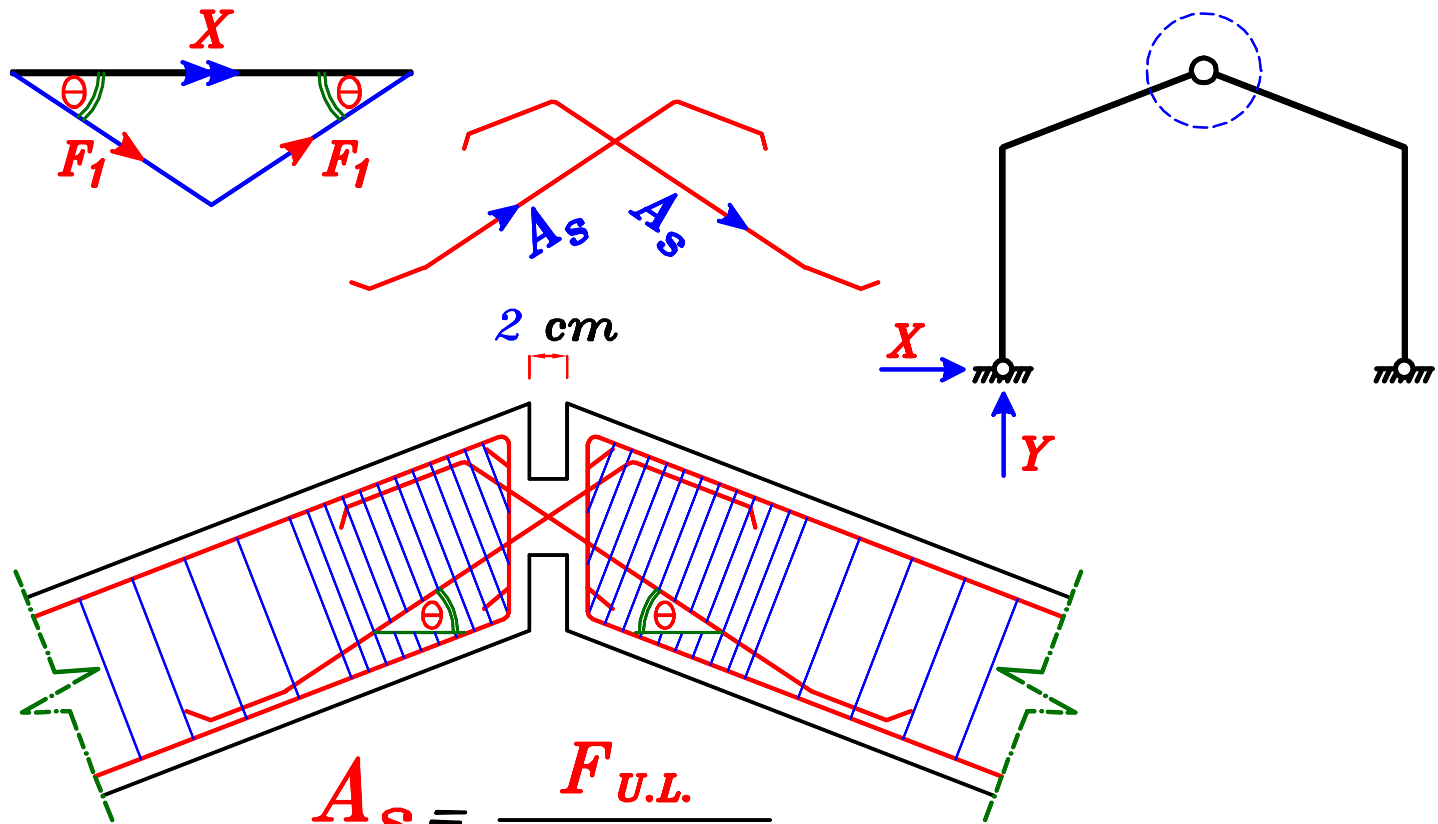
IF using $\phi 10 \longrightarrow A_s = 78.5\ mm^2$



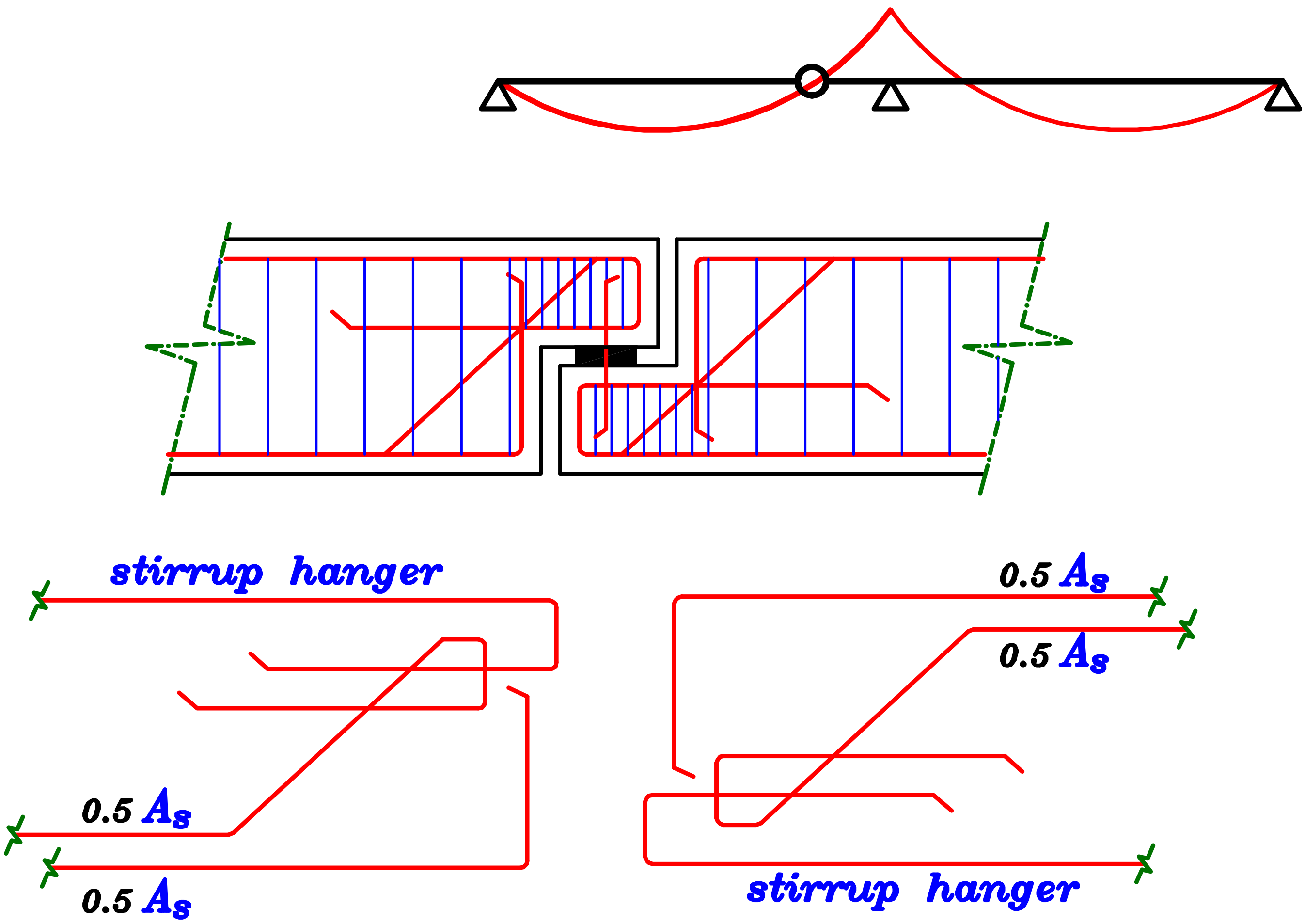
Take $A_s = \phi 8$ OR $\phi 10$ $\xrightarrow{Get}$ $n = \checkmark$ stirrup \ t

$\therefore$ Get No. of stirrups \ m` $= \frac{1.0\,m}{t} * n$

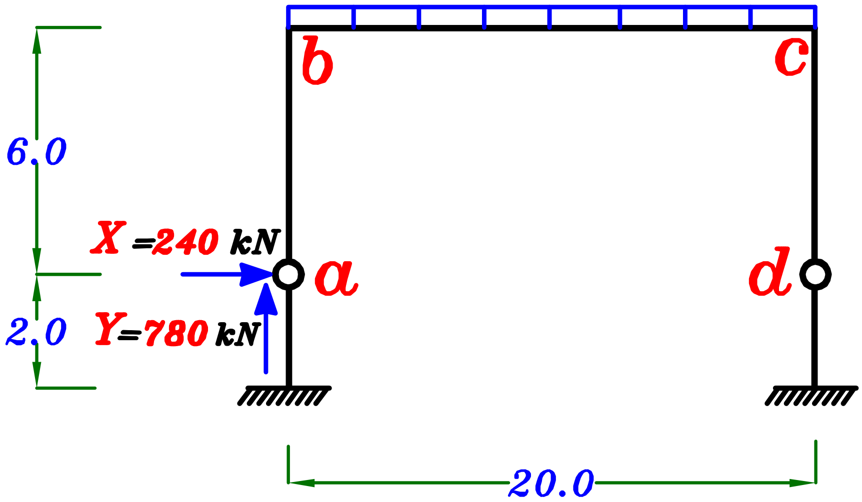
Intermediate Hinges.



$$A_s = \frac{F_{U.L.}}{0.6\ (F_y \backslash \gamma_s)}$$



Example.



* $F_{cu} = 25 \quad N \backslash mm^2$
* $F_y = 360 \quad N \backslash mm^2$

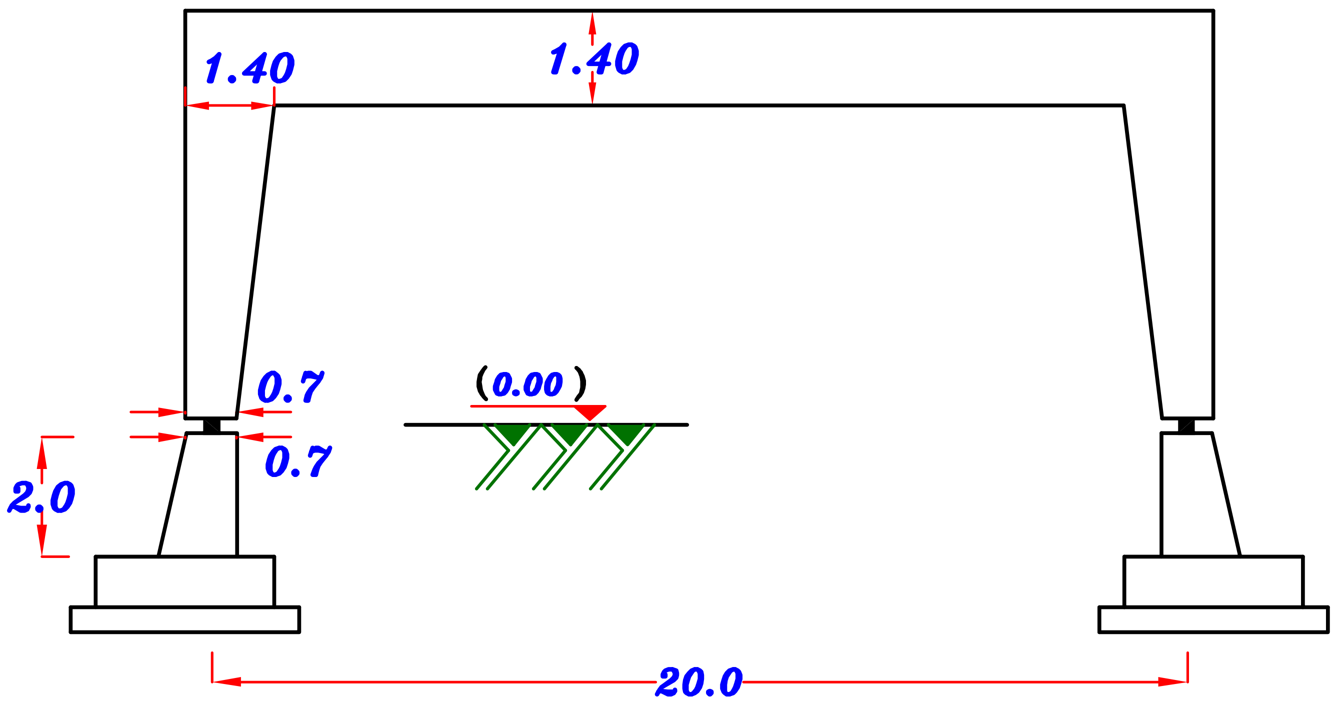
The shown Fixed Frame has a hinges at a & d
The reactions at the hinges From vertical load only are :

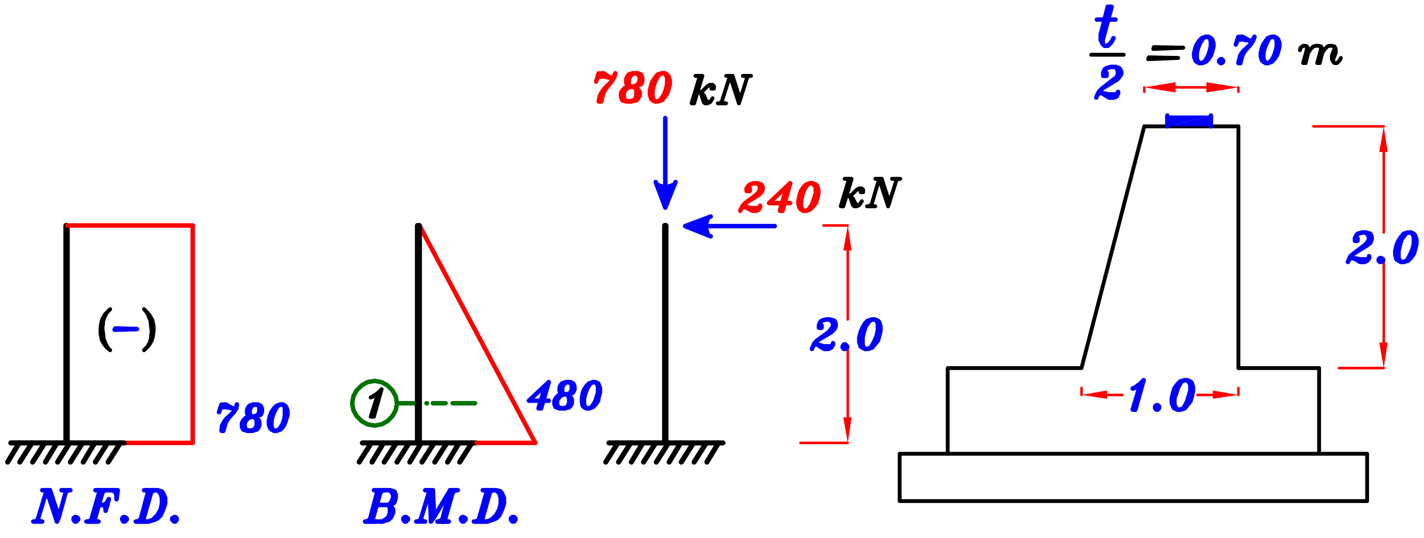
$Y = 780$ kN , $X = 240$ kN

1- Design the hinge at ((a))
2- Design the column head underneath the hinge.
The clear height of the column head H_o is 2.0 m
3- Draw to scale 1:25 a sectional elevation and cross sections to show the concrete dimensions and RFT. of the hinge and the column.

Solution.

Take $t_{(Frame)} = \dfrac{L}{12 \rightarrow 14} = \dfrac{20}{12 \rightarrow 14} = (1.66 \rightarrow 1.42) = 1.40$ m





Sec. ① R−Sec. $b = 400\ mm$, $t = 1000\ mm$

$M = 480\ kN.m$, $P = 780\ kN$

Check $\frac{P}{F_{cu}\, b\, t} = \frac{780 * 10^3}{25 * 400 * 1000} = 0.078 > 0.04$ (Don't neglect P)

$e = \frac{M}{P} = \frac{480}{780} = 0.615\ m$ $\quad \therefore \frac{e}{t} = \frac{0.615}{1.0} = 0.615 > 0.5 \xrightarrow{use} e_s$

$e_s = e + \frac{t}{2} - c = 0.615 + \frac{1.0}{2} - 0.05 = 1.065\ m$

$M_s = P * e_s = 780 * 1.065 = 830.7\ kN.m$

$\therefore 950 = C_1 \sqrt{\frac{830.7 * 10^6}{25 * 400}} \longrightarrow C_1 = 3.15 \longrightarrow J = 0.757$

$\therefore A_s = \frac{M_s}{J\, F_y\, d} - \frac{P_{U.L.}}{(F_y \backslash \gamma_s)} = \frac{830.7 * 10^6}{0.768 * 360 * 950} - \frac{780 * 10^3}{(360 \backslash 1.15)} = 671.0\ mm^2$

Check $A_{s_{min.}}$ $\quad A_{s\ req.} = 671.0\ mm^2$

$\mu_{min.}\, b\, d = \left(0.225 * \frac{\sqrt{F_{cu}}}{F_y}\right) b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 400 * 950 = 1187.5\ mm^2$

$\therefore \mu_{min.}\, b\, d > A_{s_{req.}} \xrightarrow{Use} A_{s_{min.}}$

$A_{s_{min.}} = 0.225 * \frac{\sqrt{F_{cu}}}{F_y}\, b\, d = \left(0.225 * \frac{\sqrt{25}}{360}\right) 400 * 950 = 1187.5$

$1.3\, A_{s_{req.}} = 1.3 * 671.0 = 872.3$

الأقل $= 872.3$

st. 360/520 $\quad \frac{0.15}{100}\, b\, d = \frac{0.15}{100} * 400 * 950 = 570\ mm^2$

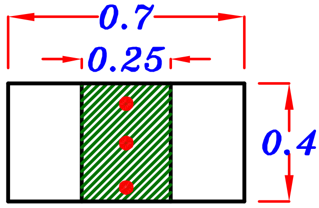
الأكبر $= 872.3\ mm^2$

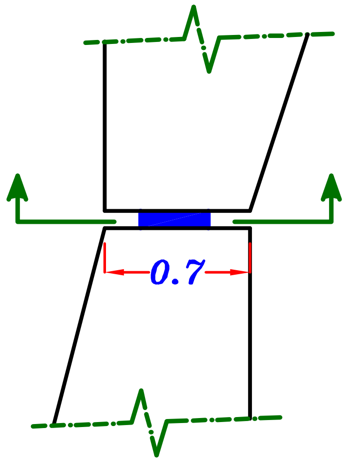
4 φ 18

Design the Hinged Support.

Using Lead Plate Hinge.

Take the dimensions of the lead Plate (250 * 400 * 40)





$$A_s = \frac{X_{U.L.}}{0.60\,(F_y \backslash \delta_s)} = \frac{240 * 10^3}{0.60\,(360 \backslash 1.15)} = 1277 \ mm^2$$

3 ϕ 25

Check Bearing.

$$F_{b\,all} = \frac{2}{3}\,\frac{F_{cu}}{\delta_c}\sqrt{\frac{A_2}{A_1}} = \frac{2}{3}\,\frac{F_{cu}}{\delta_c}\sqrt{3} = \frac{2}{3}\left(\frac{25}{1.5}\right)\sqrt{3} = 19.245 \ N\backslash mm^2$$

$$F_{b\,act.} = \frac{Y_{U.L.}}{(b * \frac{t}{3})} = \frac{780 * 10^3}{250 * 400} = 7.80 \ N\backslash mm^2$$

$$\boxed{\because \ F_{b\,all} \geqslant F_{b\,act.} \quad \therefore \ Safe}$$

Calculation of Stirrups.

$$T = \frac{Y}{6} = \frac{780}{6} = 130 \ kN$$

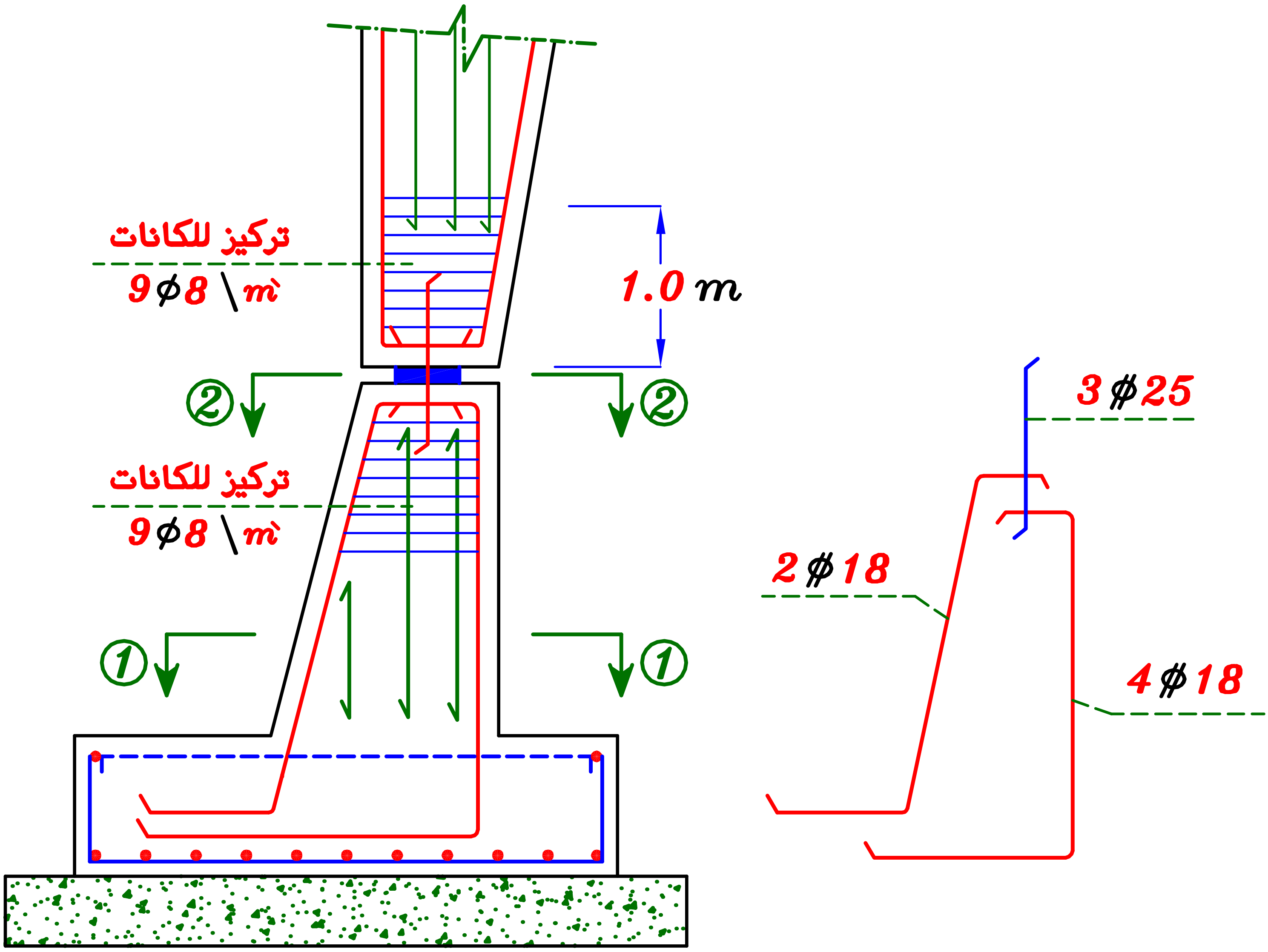
$\because \ T = 2\,n\,A_s\left(\frac{F_y}{\delta_s}\right)$ Take ϕ 8 $\longrightarrow$ $A_s = 50.3 \ mm^2$

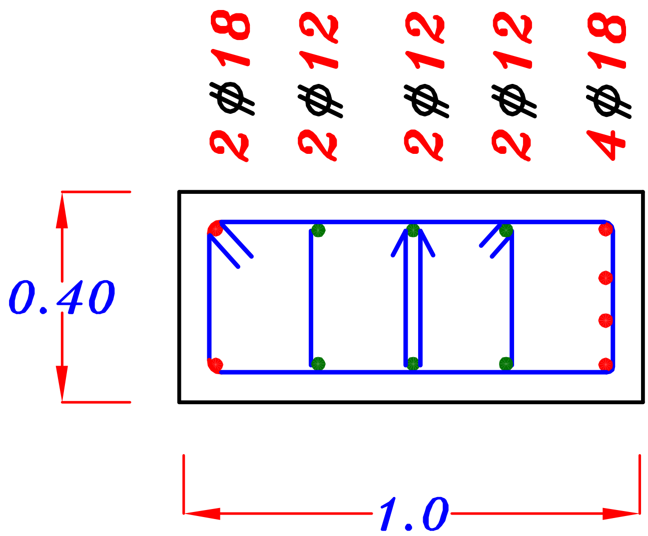
$\therefore \ 130 * 10^3 = 2\,n\,(50.3)\left(\frac{240}{1.15}\right) \longrightarrow n = 6.19$ stirrups\ 0.7 m

$\therefore$ No. of stirrups \m` $= \frac{1.0 \ m}{0.7} * 6.19 = 8.845$ stirrups\ m`

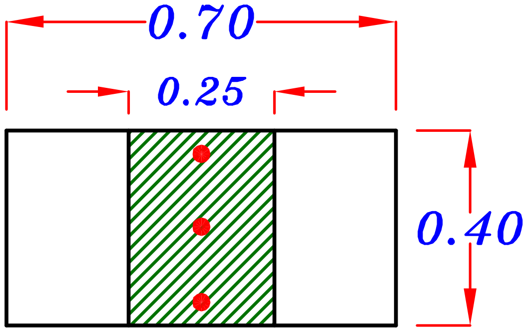
$\therefore$ Use Stirrups 9 ϕ 8 \m` 2 branches.

RFT. of the hinge & the Column head.





Sec. (1–1)



Sec. (2–2)